

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES :**Geotechnical Report:**

Delete the current Geotechnical Report with the attached Geotechnical Report.

Specifications:

Section 00800: Add the following paragraph: "Notice to Proceed will be issued only after the Pinelands Commission issues a permit for this project. Permit application has been made and permit is expected to be issued not later than 120 days after contract award."

Section 02510: Add this specification section to the project. This section covers the water line and fire hydrant replacement at the apron.

Section 02749: Add this specification to the project. This section covers bituminous pavement for the airfield pavement. Section 02257 Bituminous Pavement – New Jersey is still applicable for all shoulders.

Section 05550: Blast Deflector was revised to incorporate changes as a result of bidding questions from the supplier.

Section 16111: Add this specification.

Section 16415: This specification was revised.

Section 16450: Add this specification.

Section 16560: Add this specification.

Drawings:

Amendment Two includes the following drawing modifications.

1. General:

Sheet G-100 – Changed Drawing Index. (Drawing Reissued)

Sheet G-500 – Added Security and Access Notes. Added gates, truck entry and check point locations. (Drawing Reissued)

2. Geotechnical:

Sheet B-100 – Added Location of Borings 36-46. (Drawing Reissued)

Sheet B-107 – Added Boring Logs 36-42. (Drawing Issued)

Sheet B-108 – Added Boring Logs 43-46. (Drawing Issued)

3. Civil:

Sheet C-100 – Water Line Removal added. (Drawing Reissued)

Sheet C-102 – Revised Sheet Note #1. (Drawing Reissued)

Sheet C-106 – Revised Sheet Note #1. (Drawing Reissued)

Sheet C-600 – Added Fire Hydrants and notes #9 and #10. (Drawing Reissued)

Sheet C-602 – Modified Drainage Schedule. (Drawing Reissued)

Sheet C-814 – New Sheet - Water Details. (Drawing Issued)

4. Electrical

Sheet EA403 – Removed “concrete encased” from sheet note #1. (Drawing Reissued)

Sheet EA404 – Removed “concrete encased” from sheet note #1. (Drawing Reissued)

Sheet EA405 – Removed “concrete encased” from sheet note #1. (Drawing Reissued)

Sheet EA406 – Removed “concrete encased” from sheet note #1, added sheet note #2 clarifying cable. (Drawing Reissued)

Sheet EA407 – Removed “concrete encased” from sheet note #1. (Drawing Reissued)

Sheet EA408 – Clarified use of existing duct bank. (Drawing Reissued)

Sheet EA409 – Clarified use of existing duct bank. (Drawing Reissued)

Sheet EA410 – Clarified use of existing duct bank. (Drawing Reissued)

Sheet EA504 – Edited description of obstruction light fixture. (Drawing Reissued)

(End of Summary of Changes)

SECTION 02510A

WATER DISTRIBUTION SYSTEM
05/02**Amendment 2**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1996) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153	(1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm through 610 mm) and 54 In. through 64 In. (1,400 mm through 1,600 mm) for Water Service
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C500	(1993; C500a) Metal-Sealed Gate Valves for Water Supply Service
AWWA C502	(1994; C502a) Dry-Barrel Fire Hydrants
AWWA C509	(1994; Addendum 1995) Resilient-Seated Gate Valves for Water Supply Service

SAFETY PAYS		
Ft Dix NJ	Parking Apron / Taxiway	001515
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances	
AWWA C606	(1997) Grooved and Shouldered Joints	
ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)		
ACPPA 1344	(1988) Recommended Work Practices for A/C Pipe	
DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)		
DIPRA TRD	(1997) Thrust Restraint Design for Ductile Iron Pipe	
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)		
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves	
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)		
NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances	
NSF INTERNATIONAL (NSF)		
NSF 61	(1999) Drinking Water System Components - Health Effects (Sections 1-9)	
THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)		
SSPC Paint 21	(1991) White or Colored Silicone Alkyd Paint	
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)	

1.2 PIPING

This section covers water distribution lines, and connections to building service at a point approximately 1.5 m outside buildings and structures to which service is required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

1.2.1 NOT USED

1.2.2 Distribution Lines 80 mm (3 Inches) or Larger

Piping for water distribution lines 80 mm (3 inches) or larger shall be ductile iron, unless otherwise shown or specified.

1.2.3 NOT USED

1.2.4 Sprinkler Supply Lines

Piping for water lines supplying sprinkler systems for building fire protection shall conform to NFPA 24 from the point of connection with the water distribution system to the building 1.5 m line.

1.2.5 Potable Water Lines

Piping and components of potable water systems which come in contact with the potable water shall conform to NSF 61.

1.2.6 NOT USED

1.2.7 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

1.3 NOT USED

1.4 NOT USED

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Installation;

The manufacturer's recommendations for each material or procedure to be utilized.

Waste Water Disposal Method; G, RO.

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

SD-06 Test Reports

Bacteriological Disinfection; G, RO.

Test results from commercial laboratory verifying disinfection.

1.6 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or

lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

1.6.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 NOT USED

2.1.2 NOT USED

2.1.3 NOT USED

2.1.4 NOT USED

2.1.5 Ductile-Iron Pipe

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 1.03 MPa (150 psi), unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

2.2 FITTINGS AND SPECIALS

2.2.1 NOT USED

2.2.2 NOT USED

2.2.3 NOT USED

2.2.4 Ductile-Iron Pipe System

Fittings and specials shall be suitable for 1.03 MPa (150 psi) pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to

AWWA C153.

2.3 JOINTS

2.3.1 NOT USED

2.3.2 NOT USED

2.3.3 NOT USED

2.3.4 NOT USED

2.3.5 Ductile-Iron Pipe Jointing

a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.

b. Push-on joints shall conform to AWWA C111.

c. Rubber gaskets and lubricants shall conform to the applicable requirements of AWWA C111.

2.3.6 NOT USED

2.3.7 NOT USED

2.3.8 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.4 VALVES

2.4.1 NOT USED

2.4.2 Gate Valves

Gate valves shall be designed for a working pressure of not less than 1.03 MPa (150 psi). Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

- a. Valves smaller than 80 mm (3 inches) shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.
- b. Valves 80 mm (3 inches) and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.
- c. Resilient-Seated Gate Valves: For valves 80 to 300 mm (3 to 12 inches) in size, resilient-seated gate valves shall conform to AWWA C509.

2.4.3 NOT USED

2.4.4 NOT USED

2.4.5 NOT USED

2.4.6 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which shall be attached to each post.

2.5 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 5 mm. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

2.6 NOT USED

2.7 FIRE HYDRANTS

Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 125 mm (5 inches) in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 200 mm above the ground grade. Hydrants shall have a 150 mm (6 inch) bell connection, two 65 mm (2-1/2 inch) hose connections and one 115 mm (4-1/2 inch) pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with 1 coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and 2 finish coats of silicone alkyd paint conforming to SSPC Paint 21, of the installation's standard colors or as directed by the Contracting Officer. Suitable bronze adapter for the 115 mm (4-1/2 inch) outlet, with caps, shall be furnished.

2.8 NOT USED

2.9 MISCELLANEOUS ITEMS

2.9.1 NOT USED

2.9.2 NOT USED

2.9.3 NOT USED

2.9.4 NOT USED

2.9.5 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 1.03 MPa. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 67.8 Newton meters (50 foot-pound).

2.9.6 NOT USED

2.9.7 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

3.1.2 Adjacent Facilities

3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 3 m from a sewer except where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 1.8 m from the sewer. Where

water lines cross under gravity-flow sewer lines, the sewer pipe, for a distance of at least 3 m each side of the crossing, shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 900 mm horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 600 mm above the sewer main. Joints in the sewer main, closer horizontally than 900 mm to the crossing, shall be encased in concrete.

3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

3.1.2.3 Copper Tubing Lines

Copper tubing shall not be installed in the same trench with ferrous piping materials.

3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes.

3.1.3 Joint Deflection

3.1.3.1 NOT USED

3.1.3.2 NOT USED

3.1.3.3 Allowable for Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

3.1.4.1 NOT USED

3.1.4.2 NOT USED

3.1.4.3 Piping Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA 1344.

3.1.4.4 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.4.5 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.5 Jointing

3.1.5.1 NOT USED

3.1.5.2 NOT USED

3.1.5.3 NOT USED

3.1.5.4 NOT USED

3.1.5.5 Ductile-Iron Pipe Requirements

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

3.1.5.6 NOT USED

3.1.5.7 NOT USED

3.1.5.8 NOT USED

3.1.5.9 NOT USED

3.1.5.10 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm thickness of coal tar over all fitting surfaces.

3.1.5.11 Transition Fittings

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

3.1.6 NOT USED

3.1.7 NOT USED

3.1.8 Setting of Fire Hydrants, Valves and Valve Boxes

3.1.8.1 Location of Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 150 mm (6 inch) branch line having at least as much cover as the distribution main. Hydrants shall be set plumb with pumper nozzle facing the roadway, with the center of the lowest outlet not less than 450 mm above the finished surrounding grade, and the operating nut not more than 1.2 m above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 450 mm above the finished surrounding grade, the top of the hydrant not more than 600 mm above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished grade immediately after installation to obtain beneficial use of the hydrant as soon as practicable. The hydrant shall be set upon a slab of concrete not less than 100 mm thick and 400 mm square. Not less than 2 cubic meters of free-draining broken stone or gravel shall be placed around and beneath the waste opening of dry barrel hydrants to ensure drainage.

3.1.8.2 NOT USED

3.1.8.3 Location of Valves

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be tamped around each valve box or pit to a distance of 1.2 m on all sides of the box, or the undisturbed trench face if less than 1.2 m.

3.1.9 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

3.1.10 Thrust Restraint

Plugs, caps, tees and bends deflecting 11.25 degrees or more, either vertically or horizontally, on waterlines 100 mm (4 inches) in diameter or larger, and fire hydrants shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.10.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the

hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.10.2 Restrained Joints

For ductile-iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA TRD.

3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved.

3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions is encountered:

- a. Wet or unstable soil conditions in the trench.
- b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.
- c. Maintaining the trench in an open condition would delay completion of the project.

The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than 1.38 MPa pressure. Leakage is defined as the quantity of water

to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 34.5 kPa (5 psi) of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

$$L = 0.0001351ND(P \text{ raised to } 0.5 \text{ power})$$

L = Allowable leakage in gallons per hour

N = Number of joints in the length of pipeline tested

D = Nominal diameter of the pipe in inches

P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be as specified. Replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

- a. Pressure test and leakage test may be conducted concurrently.
- b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

3.3 BACTERIAL DISINFECTION

3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as specified. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in

solution. The agent shall not be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. Valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each fire hydrant on the line shall be opened and closed several times. From several points in the unit, personnel from the Contractor's commercial laboratory shall take at least 3 water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory shall be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

3.4 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

SECTION 02749

HOT-MIX ASPHALT (HMA) FOR AIRFIELDS
03/02

AMENDMENT 2

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO MP 1	(1998) Provisional Specification for Performance Graded Asphalt Binder
AASHTO TP53	(2000) Determining Asphalt Content of Hot Mix Asphalt by the Ignition Method **

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 1252	(1998) Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 29/C 29M	(1997) Bulk Density ("Unit Weight") and Voids in Aggregates
ASTM C 566	(1997) Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 88	(1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 140	(2000) Sampling Bituminous Materials
ASTM D 1461	(1985; R 1994) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 1559	(1989) Resistance to Plastic Flow of

Bituminous Mixtures Using Marshall
Apparatus \N(Deleted; continued use
without replacement.)

ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2419	(1995) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
ASTM D 2489	(2000) Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D 2726	(2000) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixture
ASTM D 2950	(1997) Density of Bituminous Concrete in Place by Nuclear Method
ASTM D 3203	(1994; R 2000) Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D 3381	(1992; R 1999) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3665	(1999) Random Sampling of Construction Materials
ASTM D 3666	(2000) Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
ASTM D 4125	(1994e1) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D 4791	(1999) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 4867/D 4867M	(1996) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 5444	(1998) Mechanical Size Analysis of Extracted Aggregate
ASTM D 6307	(1998) Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D 946	(1982; R 1999) Penetration-Graded Asphalt Cement for Use in Pavement Construction

ASTM D 995 (1995b) Mixing Plants for Hot-Mixed,
Hot-Laid Bituminous Paving Mixtures

ASPHALT INSTITUTE (AI)

AI MS-02 (1997) Mix Design Methods for Asphalt
Concrete and Other Hot-Mix Types

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CDT)

CDT Test 526 (1978) Operation of California
Profilograph and Evaluation of Profiles

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 171 (1995) Test Method for Determining
Percentage of Crushed Particles in
Aggregate

1.2 DESCRIPTION OF WORK

The work shall consist of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design; G, RO

Proposed JMF.

Contractor Quality Control; G, RO

Quality control plan.

SD-06 Test Reports

Aggregates; G, RO

Aggregate and QC test results.

SD-07 Certificates

Asphalt Cement Binder; G, RO

Copies of certified test data.

Testing Laboratory;

Certification of compliance.

1.4 METHOD OF MEASUREMENT

Measurement of the quantity of hot-mix asphalt, per ton placed and accepted, shall be made for the purposes of assessing the pay factors stipulated in this section.

1.5 BASIS OF PAYMENT

The measured quantity of hot-mixed asphalt will be paid for and included in the lump-sum contract price. If less than 100 percent payment is due based on the pay factors stipulated in paragraph MATERIAL ACCEPTANCE AND PERCENT PAYMENT, a unit price of \$29 per ton shall be used for purposes of calculating the payment reduction.

1.6 ASPHALT MIXING PLANT

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of ASTM D 995 with the following changes:

a. Truck Scales. The asphalt mixture shall be weighed on approved scales furnished by the Contractor, or on certified public scales at the Contractor's expense. Scales shall be inspected and sealed at least annually by an approved calibration laboratory.

b. Testing Facilities. The Contractor shall provide laboratory facilities at the plant for the use of the Government's Engineer's acceptance testing and the Contractor's quality control testing.

c. Inspection of Plant. The Contracting Officer Engineer shall have access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. The Contractor shall provide assistance as requested, for the Government Engineer to procure any desired samples.

d. Storage Bins. The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours. The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

1.7 HAULING EQUIPMENT

Trucks used for hauling hot-mix asphalt shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

1.8 ASPHALT PAVERS

Asphalt pavers shall be self-propelled, with an activated screed, heated as necessary, and shall be capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

1.8.1 Receiving Hopper

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

1.9 ROLLERS

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Equipment which causes excessive crushing of the aggregate shall not be used.

1.10 WEATHER LIMITATIONS

The hot-mix asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 1. The temperature requirements may be waived by the Contracting Officer Engineer, if requested; however, all other requirements, including compaction, shall be met.

Table 1. Surface Temperature Limitations of Underlying Course

Mat Thickness, mm	Degrees C
75 or greater	4
Less than 75	7

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The portion of material retained on the 4.75 mm sieve is coarse aggregate. The portion of material passing the 4.75 mm sieve and retained on the 0.075 mm sieve is fine aggregate. The portion passing the 0.075 mm sieve is defined as mineral filler. All aggregate test results and samples shall be submitted to the Contracting Officer Engineer at least 14 days prior to start of construction.

2.1.1 Coarse Aggregate

Coarse aggregate shall consist of sound, tough, durable particles, free

from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. The coarse aggregate particles shall meet the following requirements:

a. The percentage of loss shall not be greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.

b. The percentage of loss shall not be greater than 18 percent after five cycles when tested in accordance with ASTM C 88 using magnesium sulfate.

c. At least 75 percent by weight of coarse aggregate shall have at least two or more fractured faces when tested in accordance with COE CRD-C 171. Fractured faces shall be produced by crushing.

d. The particle shape shall be essentially cubical and the aggregate shall not contain more than 20 percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D 4791.

e. Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 1200 kg/cubic meter when tested in accordance with ASTM C 29/C 29M.

2.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles. The aggregate particles shall be free from coatings of clay, silt, or any objectionable material and shall contain no clay balls. The fine aggregate particles shall meet the following requirements:

a. The quantity of natural sand (noncrushed material) added to the aggregate blend shall not exceed 15 percent by weight of total aggregate.

b. The individual fine aggregate sources shall have a sand equivalent value greater than 45 when tested in accordance with ASTM D 2419.

c. The fine aggregate portion of the blended aggregate shall have an uncompacted void content greater than 45.0 percent when tested in accordance with ASTM C 1252 Method A.

2.1.3 Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D 242.

2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table 2, when tested in accordance with ASTM C 136 and ASTM C 117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table 2. Aggregate Gradations

Gradation 2	
Sieve Size, mm	Percent Passing by Mass
25.0	---
19.0	100
12.5	76-96
9.5	69-89
4.75	53-73
2.36	38-60
1.18	26-48
0.60	18-38
0.30	11-27
0.15	6-18
0.075	3-6

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to AASHTO MP 1 Performance Grade (PG) 58-28. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer Engineer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer Engineer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D 140 and in the presence of the Contracting Officer Engineer. These samples shall be furnished to the Contracting Officer Engineer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-02 and the criteria shown in Table 3. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. Sufficient materials to produce 90 kg of blended mixture shall be provided to the Contracting Officer Engineer for verification of mix design at least 14 days prior to construction of test section.

2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

- a. Percent passing each sieve size.
- b. Percent of asphalt cement.
- c. Percent of each aggregate and mineral filler to be used.
- d. Asphalt viscosity grade, penetration grade, or performance grade.
- e. Number of blows of hammer per side of molded specimen.
- f. Laboratory mixing temperature.
- g. Lab compaction temperature.
- h. Temperature-viscosity relationship of the asphalt cement.
- i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.
- j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-02.
- k. Specific gravity and absorption of each aggregate.
- l. Percent natural sand.
- m. Percent particles with two or more fractured faces (in coarse aggregate).
- n. Fine aggregate angularity.
- o. Percent flat or elongated particles (in coarse aggregate).
- p. Tensile Strength Ratio.
- q. Antistrip agent (if required) and amount.
- r. List of all modifiers and amount.
- s. Percentage and properties (asphalt content, binder properties, and aggregate properties) of RAP in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

Table 3. Marshall Design Criteria

Test Property	75 Blow Mix
Stability, newtons minimum	*9560
Flow, 0.25 mm	8-16
Air voids, percent	3-5

Table 3. Marshall Design Criteria

Test Property	75 Blow Mix
Percent Voids in mineral aggregate (minimum)	See Table 4
TSR, minimum percent	75

* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Table 4. Minimum Percent Voids in Mineral Aggregate (VMA)**

Aggregate (See Table 2)	Minimum VMA, percent
Gradation 2	14.0

** Calculate VMA in accordance with AI MS-02, based on ASTM D 2726 bulk specific gravity for the aggregate.

2.3.2 Adjustments to JMF

The JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer Engineer. Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the JMF within the limits specified below to optimize mix volumetric properties. Adjustments to the JMF shall be limited to plus or minus 3 percent on the 12.5 mm, 4.75 mm, and 2.36 mm sieves; plus or minus 1.0 percent on the 0.075 mm sieve; and plus or minus 0.40 percent binder content. If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table 2; this is acceptable.

2.4 RECYCLED HOT MIX ASPHALT

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 50 mm. The recycled HMA mix shall be designed using procedures contained in AI MS-02. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP shall be limited to 30 percent.

2.4.1 RAP Aggregates and Asphalt Cement

The blend of aggregates used in the recycled mix shall meet the requirements of paragraph AGGREGATES. The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D 2172 using the appropriate dust correction procedure.

2.4.2 RAP Mix

The blend of new asphalt cement and the RAP asphalt binder shall meet the dynamic shear rheometer at high temperature and bending beam at low temperature requirements in paragraph ASPHALT CEMENT BINDER. The virgin asphalt cement shall not be more than two standard asphalt material grades different than that specified in paragraph ASPHALT CEMENT BINDER.

PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C when added to the aggregates. Modified asphalts shall be no more than 174 degrees C when added to the aggregates.

3.2 PREPARATION OF MINERAL AGGREGATE

The aggregate for the mixture shall be heated and dried prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 175 degrees C when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but no less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used.

The wet mixing time will be set to at least achieve 95 percent of coated particles. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D 1461.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, the underlying course shall be cleaned of dust and debris. A prime coat and/or tack coat shall be applied in accordance with the contract specifications.

3.5 TEST SECTION

Prior to full production, the Contractor shall place a test section for each JMF used. The contractor shall construct a test section 75 - 150 m long and two paver passes wide placed in two lanes, with a longitudinal cold joint. The test section shall be of the same depth as the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in

construction of the test section shall be the same equipment to be used on the remainder of the course represented by the test section. The test section shall be placed as part of the project pavement as approved by the Contracting Officer Engineer.

3.5.1 Sampling and Testing for Test Section

One random sample shall be taken at the plant, triplicate specimens compacted, and tested for stability, flow, and laboratory air voids. A portion of the same sample shall be tested for theoretical maximum density (TMD), aggregate gradation and asphalt content. Four randomly selected cores shall be taken from the finished pavement mat, and four from the longitudinal joint, and tested for density. Random sampling shall be in accordance with procedures contained in ASTM D 3665. The test results shall be within the tolerances shown in Table 5 for work to continue. If all test results meet the specified requirements, the test section shall remain as part of the project pavement. If test results exceed the tolerances shown, the test section shall be removed and replaced at no cost to the Government Owner and another test section shall be constructed.

Table 5. Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm and larger	JMF plus or minus 8
2.36, 1.18, 0.60, and 0.30 mm	JMF plus or minus 6
0.15 and 0.075 mm	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	14 minimum
Stability, newtons (Average of 3 specimens)	9560 minimum
Flow, 0.25 mm (Average of 3 specimens)	8 - 16
Mat Density, Percent of TMD (Average of 4 Random Cores)	93.0 - 96.5
Joint Density, Percent of TMD (Average of 4 Random Cores)	91.5 - 96.5

3.5.2 Additional Test Sections

If the initial test section should prove to be unacceptable, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Full production shall not begin until an acceptable section has been constructed and accepted.

3.6 TESTING LABORATORY

The laboratory used to develop the JMF and for Government Engineer acceptance testing shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer Engineer prior to the start of construction. The certification shall contain as a minimum:

- a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
- b. A listing of equipment to be used in developing the job mix.
- c. A copy of the laboratory's quality control system.
- d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

The hot-mix asphalt shall be transported from the mixing plant to the site in clean, tight vehicles. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Adequate artificial lighting shall be provided for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C. To deliver mix to the paver, the Contractor shall use a material transfer vehicle which shall be operated to produce continuous forward motion of the paver.

3.7.2 Placing

The mix shall be placed and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, the mixture shall be placed to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 3 m. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 300 mm; however, the joint in the surface course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 3 m from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 3 m. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

3.8 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by

rolling. The surface shall be compacted as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor, with the exception that the Contractor shall not apply more than three passes with a vibratory roller in the vibrating mode. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

3.9 JOINTS

The formation of joints shall be made ensuring a continuous bond between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

The roller shall not pass over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. The cutback material shall be removed from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C at the time of placing the adjacent lane), or otherwise defective, shall be cut back a minimum of 50 mm from the edge with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

3.10 CONTRACTOR QUALITY CONTROL

3.10.1 General Quality Control Requirements

The Contractor shall develop an approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the quality control plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

- a. Mix Design
- b. Aggregate Grading
- c. Quality of Materials
- d. Stockpile Management
- e. Proportioning
- f. Mixing and Transportation
- g. Mixture Volumetrics
- h. Moisture Content of Mixtures
- i. Placing and Finishing
- j. Joints
- k. Compaction
- l. Surface Smoothness

3.10.2 Testing Laboratory

The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. The effective working area of the laboratory shall be a minimum of 14 square meters with a ceiling height of not less than 2.3 m. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 24 degrees C plus or minus 2.3 degrees C. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Contracting Officer Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.10.3 Quality Control Testing

The Contractor shall perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability, flow, in-place density, grade and smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

3.10.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per lot (a lot is defined in paragraph MATERIAL ACCEPTANCE AND PERCENT PAYMENT) by one of the following methods: extraction method in accordance with ASTM

D 2172, Method A or B, the ignition method in accordance with the AASHTO TP53, ASTM D 6307, or the nuclear method in accordance with ASTM D 4125, provided the nuclear gauge is calibrated for the specific mix being used. For the extraction method, the weight of ash, as described in ASTM D 2172, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.10.3.2 Gradation

Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D 5444. When asphalt content is determined by the nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, aggregates shall be tested in accordance with ASTM C 136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.10.3.3 Temperatures

Temperatures shall be checked at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.10.3.4 Aggregate Moisture

The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C 566.

3.10.3.5 Moisture Content of Mixture

The moisture content of the mixture shall be determined at least once per lot in accordance with ASTM D 1461 or an approved alternate procedure.

3.10.3.6 Laboratory Air Voids, Marshall Stability and Flow

Mixture samples shall be taken at least four times per lot and compacted into specimens, using 75 blows per side with the Marshall hammer as described in ASTM D 1559. After compaction, the laboratory air voids of each specimen shall be determined, as well as the Marshall stability and flow.

3.10.3.7 In-Place Density

The Contractor shall conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D 2950.

3.10.3.8 Grade and Smoothness

The Contractor shall conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph MATERIAL ACCEPTANCE AND PERCENT PAYMENT.

3.10.3.9 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

3.10.3.10 QC Monitoring

The Contractor shall submit all QC test results to the Contracting Officer Engineer on a daily basis as the tests are performed. The Contracting Officer Engineer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.10.4 Sampling

When directed by the Contracting Officer Engineer, the Contractor shall sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

3.10.5 Control Charts

For process control, the Contractor shall establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 6, as a minimum. These control charts shall be posted as directed by the Contracting Officer Engineer and shall be kept current at all times. The control charts shall identify the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 6 applicable to the test parameter being plotted, and the Contractor's test results. Target values from the JMF shall also be shown on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, the Contractor shall take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, the Contractor shall halt production until the problem is solved. The Contractor shall use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Decisions concerning mix modifications shall be made based on analysis of the results provided in the control charts. The Quality Control Plan shall indicate the appropriate action which shall be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 6. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

Parameter to be Plotted	Individual Samples		Running Average of Last Four Samples	
	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	6	8	4	5
0.6 mm sieve, Cumulative %	4	6	3	4

Table 6. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

Parameter to be Plotted	Individual Samples		Running Average of Last Four Samples	
	Action Limit	Suspension Limit	Action Limit	Suspension Limit

Passing, deviation from JMF target; plus or minus values				
0.075 mm sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	1.4	2.0	1.1	1.5
Stability, newtons (minimum)				
75 blow JMF	7830	7290	9560	9030
50 blow JMF	4230	3690	6000	5470
Flow, 0.25 mm				
75 blow JMF	8 min. 16 max.	7 min. 17 max.	9 min. 15 max.	8 min. 16 max.
50 blow JMF	8 min. 18 max.	7 min. 19 max.	9 min. 17 max.	8 min. 18 max.
Asphalt content, % deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Laboratory Air Voids, % deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Mat Density, % of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Joint Density, % of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			

3.11 MATERIAL ACCEPTANCE AND PERCENT PAYMENT

The Government's Engineer's quality assurance (QA) program for this project, specified below, will be separate and distinct from the Contractor's quality control (QC) program specified above. Testing for acceptability of work will be performed by the Government Engineer or by an independent laboratory hired by the Contracting Officer Engineer, except for grade and smoothness testing which shall be performed by the Contractor. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 2000 metric tons. Where appropriate, adjustment in payment for individual lots of hot-mix asphalt will be made based on in-place density, laboratory air voids, grade and smoothness in accordance with the following paragraphs. Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in

situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in-place (field) density, each lot will be divided into four equal sublots.

3.11.1 Percent Payment

When a lot of material fails to meet the specification requirements for 100 percent pay as outlined in the following paragraphs, that lot shall be removed and replaced, or accepted at a reduced price which will be computed by multiplying the unit price by the lot's pay factor. The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, grade or smoothness (each discussed below). Pay factors based on different criteria (i.e., laboratory air voids and in-place density) of the same lot will not be multiplied together to get a lower lot pay factor. At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.1 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2000 metric tons, a weighted lot pay factor will be used to calculate the average lot pay factor.

3.11.2 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Contracting Officer Engineer desires, will be taken from a loaded truck delivering mixture to each sublot, or other appropriate location for each sublot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D 3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sublot sample in accordance with ASTM D 1559. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

3.11.3 Additional Sampling and Testing

The Contracting Officer Engineer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government Owner. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.11.4 Laboratory Air Voids and Theoretical Maximum Density

Laboratory air voids will be calculated in accordance with ASTM D 3203 by determining the Marshall density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method in ASTM D 2726 and determining the theoretical maximum density (TMD) of every other sublot sample using ASTM D 2041. Laboratory air void calculations for each sublot will use the latest theoretical maximum density values obtained, either for that sublot or the previous sublot. The mean absolute deviation of the four laboratory

air void contents (one from each subplot) from the JMF air void content will be evaluated and a pay factor determined from Table 7. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot. The TMD is also used for computation of compaction, as required in paragraph: Mat and Joint Densities.

3.11.5 Mean Absolute Deviation

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each subplot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

$$\text{Mean Absolute Deviation} = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4$$

$$= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45$$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 7 that the lot's pay factor based on laboratory air voids, is 100 percent.

Table 7. Pay Factor Based on Laboratory Air Voids

Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, %
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	reject (0)

3.11.6 In-place Density

3.11.6.1 General Density Requirements

For determining in-place density, one random core (100 mm or 150 mm in diameter) will be taken by the Government Engineer from the mat (interior of the lane) of each subplot, and one random core will be taken from the joint (immediately over joint) of each subplot. Each random core will be full thickness of the layer being placed. When the random core is less than 25 mm thick, it will not be included in the analysis. In this case, another random core will be taken. After air drying in accordance with ASTM D 2726 for laboratory-prepared, thoroughly dry specimens, cores obtained from the mat and from the joints will be used for in-place density determination.

3.11.6.2 Mat and Joint Densities

The average in-place mat and joint densities are expressed as a percentage of the average TMD for the lot. The average TMD for each lot will be determined as the average TMD of the two random samples per lot. The average in-place mat density and joint density for a lot are determined and compared with Table 8 to calculate a single pay factor per lot based on in-place density, as described below. First, a pay factor for both mat density and joint density are determined from Table 8. The area associated

with the joint is then determined and will be considered to be 3 m wide times the length of completed longitudinal construction joint in the lot. This area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of hot-mix asphalt pavement, either an adjacent freshly paved lane or one paved at any time previously. The area associated with the joint is expressed as a percentage of the total lot area. A weighted pay factor for the joint is determined based on this percentage (see example below). The pay factor for mat density and the weighted pay factor for joint density is compared and the lowest selected. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD will be used as the TMD needed to calculate the percent joint density. All density results for a lot will be completed and reported within 24 hours after the construction of that lot.

Table 8. Pay Factor Based on In-place Density

Average Mat Density (4 Cores)	Pay Factor, %	Average Joint Density (4 Cores)

94.0 - 96.0	100.0	Above 92.5
93.9	100.0	92.4
93.8 or 96.1	99.9	92.3
93.7	99.8	92.2
93.6 or 96.2	99.6	92.1
93.5	99.4	92.0
93.4 or 96.3	99.1	91.9
93.3	98.7	91.8
93.2 or 96.4	98.3	91.7
93.1	97.8	91.6
93.0 or 96.5	97.3	91.5
92.9	96.3	91.4
92.8 or 96.6	94.1	91.3
92.7	92.2	91.2
92.6 or 96.7	90.3	91.1
92.5	87.9	91.0
92.4 or 96.8	85.7	90.9
92.3	83.3	90.8
92.2 or 96.9	80.6	90.7
92.1	78.0	90.6
92.0 or 97.0	75.0	90.5
below 92.0, above 97.0	0.0 (reject)	below 90.5

3.11.6.3 Pay Factor Based on In-place Density

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 93.2 percent (of lab TMD). (2) Average joint density = 91.5 percent (of lab TMD). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 8:

Mat density of 93.2 percent = 98.3 pay factor.

Joint density of 91.5 percent = 97.3 pay factor.

b. Step 2: Determine ratio of joint area (length of longitudinal joint x 10 ft) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 10 ft. width and divide by the mat area (total paved area in the lot).

$(2000 \text{ ft.} \times 10 \text{ ft.}) / 30000 \text{ sq.ft.} = 0.6667$ ratio of joint area to mat area (ratio).

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

$\text{wpf} = \text{joint pay factor} + (100 - \text{joint pay factor}) (1 - \text{ratio})$
 $\text{wpf} = 97.3 + (100 - 97.3) (1 - 0.6667) = 98.2\%$

d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

Pay factor for mat density: 98.3%. Weighted pay factor for joint density: 98.2%

Select the smaller of the two values as pay factor based on density: 98.2%

3.11.7 Grade

Within 5 working days after completion of a particular lot incorporating the final earing course, the Contractor shall test the final wearing surface of the pavement for conformance with specified plan grade requirements. All testing shall be performed in the presence of the Contracting Officer Engineer. The final wearing surface of pavement shall conform to the elevations and cross sections shown and shall vary not more than 9 mm for runways or 15 mm for taxiways and aprons from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels at intervals of 7.6 m, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface.

Detailed notes of the results of the testing shall be kept and a copy furnished to the Government Engineer immediately after each day's testing. When more than 5 percent of all measurements made within a lot are outside the 9 or 15 mm tolerance, the pay factor based on grade for that lot will be 95 percent. In areas where the grade exceeds the tolerance by more than 50 percent, the Contractor shall remove the surface lift full depth; the Contractor shall then replace the lift with hot-mix asphalt to meet specification requirements, at no additional cost to the Government Owner. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.11.8 Surface Smoothness

The Contractor shall use both of the following methods to test and evaluate surface smoothness of the pavement. All testing shall be performed in the

presence of the Contracting Officer Engineer. Detailed notes of the results of the testing shall be kept and a copy furnished to the Government Engineer immediately after each day's testing. The profilograph method shall be used for all longitudinal and transverse testing, except where the runs would be less than 60 m in length and the ends where the straightedge shall be used. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer Engineer.

3.11.8.1 Smoothness Requirements

a. Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavements shall be within the tolerances specified in Table 9 when checked with an approved 4 m straightedge.

Table 9. Straightedge Surface Smoothness--Pavements

Pavement Category -----	Direction of Testing -----	Tolerance, mm -----
Runways and taxiways	Longitudinal	3
	Transverse	6
Calibration hardstands and compass swinging bases	Longitudinal	3
	Transverse	3
All other airfields and helicopter paved areas	Longitudinal	6
	Transverse	6

b. Profilograph Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavement shall have a Profile Index not greater than specified in Table 10 when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 60 m, that direction shall be tested by the straightedge method and shall meet requirements specified above.

Table 10. Profilograph Surface Smoothness--Pavements

Pavement Category -----	Direction of Testing -----	Maximum Specified Profile Index (mm/km) -----
Runways	Longitudinal	110
	Transverse	140
Taxiways	Longitudinal	140
	Transverse	(Use Straightedge)
Calibration Hardstands & Compass Swinging Bases		(Use Straightedge)
All Other Airfield & Helicopter Paved Areas	Longitudinal	140
	Transverse	140

3.11.8.2 Testing Method

After the final rolling, but not later than 24 hours after placement, the surface of the pavement in each entire lot shall be tested by the Contractor in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. Separate testing of individual sublots is not required. If any pavement areas are ground, these areas shall be retested immediately after grinding. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 4.5 m or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lines less than 6.1 m and at the third points for lanes 6.1 m or greater. Other areas having obvious deviations shall also be tested. Longitudinal testing lines shall be continuous across all joints.

a. Straightedge Testing. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

b. Profilograph Testing. Profilograph testing shall be performed using approved equipment and procedures described in CDT Test 526. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. The "blanking band" shall be 5 mm wide and the "bump template" shall span 25 mm with an offset of 10 mm. The profilograph shall be operated by an approved, factory-trained operator on the alignments specified above. A copy of the reduced tapes shall be furnished the Government Engineer at the end of each day's testing.

3.11.8.3 Payment Adjustment for Smoothness

a. Straightedge Testing. Location and deviation from straightedge for all measurements shall be recorded. When between 5.0 and 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph Smoothness Requirements above, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness, will be 95 percent. When more than 10.0 percent of all measurements exceed the tolerance, the computed pay factor will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed pay factor will be 75 percent. When 20.0 percent or more of the measurements exceed the tolerance, the lot shall be removed and replaced at no additional cost to the Government Owner. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 50 percent, shall be corrected by diamond grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government Owner.

b. Profilograph Testing. Location and data from all profilograph measurements shall be recorded. When the Profile Index of a lot exceeds the tolerance specified in paragraph Smoothness Requirements above by 16 mm/km, but less than 32 mm/km, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm/km, but less than 47 mm/km, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm/km, but less than 63 mm/km, the computed pay factor will be 75 percent. When the Profile Index exceeds the tolerance by 63 mm/km or

more, the lot shall be removed and replaced at no additional cost to the Government Owner. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm/km or more, shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government Owner.

c. Bumps ("Must Grind" Areas). Any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm in height shall be reduced by diamond grinding until they do not exceed 7.5 mm when retested. Such grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. At the Contractor's option, pavement areas, including ground areas, may be rechecked with the profilograph in order to record a lower Profile Index.

-- End of Section --

SECTION 05550

BLAST DEFLECTOR
Amendment 2

PART 1 GENERAL

1.1 SUMMARY (NOT APPLICABLE)

1.2 GENERAL REQUIREMENTS

Blast deflectors shall be the product of an experienced manufacturer of blast deflectors, regularly engaged in the manufacture of blast deflectors, which have been in satisfactory use for a period of at least 2 years prior to bid opening.

The Contractor shall be responsible for the design of the deflectors, all errors of detailing and fabrication, for the correct fitting of structural members, and for the structural integrity of the blast deflector.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Blast Deflector; G-ED

Provide manufacturer's data on design of blast deflectors and their components, including fasteners and anchor bolts. This data shall incorporate size and structural properties of materials used.

SD-02 Shop Drawings

Blast Deflector; G-ED

Detail drawings shall include fabrication and erection details, and structural connections. Foundation drawings. The soil boring logs are included in the drawings. The Geotechnical report is available from the Contracting Officer.

SD-06 Test Reports

Testing; G-ED

Full scale instrumented field test results. Test shall indicate pressures and temperature at the deflector, and shall show the exhaust is deflected vertically. At the Contracting Officer's option, evidence of similar blast deflectors operating satisfactorily under given conditions may be submitted in lieu of testing.

Mill Test Reports; G-RE

Certified copies of mill test reports for structural bolts, nuts, and other related structural steel items.

SD-07 Certificates

Certificate of Guarantee

Certificate stating a 1-year guarantee on the materials and installation of the blast deflector shall be submitted by the manufacturer.

1.4 DESCRIPTION

The blast deflector shall be of the length as indicated on the drawings and shall be designed to deflect the break-away thrust jet exhaust from a C-5 aircraft. Design velocity of the jet exhaust shall be 193 kilometer per hour at a distance of 30.5 meters from the jet nozzle. The blast deflectors shall also be designed for a 145 kilometer per hour wind force acting in any direction on the blast deflectors. The blast deflector shall deflect the jet exhaust gases at a forty-five degree angle above horizontal, from the top of the deflector, with no spillover of noxious exhaust gases behind the deflector. Blast deflectors shall be solid or with pressure equalization slots curved, horizontally spanning, corrugated steel type. Blast deflectors constructed of concrete, expanded metal, perforated metal, double reverse corrugated perforated metal, or slatted chain link fabric shall not be used. Vertical or near vertical blast deflectors shall not be used. The blast deflector shall be designed to withstand the prescribed blast loads without exceeding the allowable stress of the steel, and to prevent "oil-canning" of deflecting material, which leads to early fatigue failure. The blast deflector foundation shall be designed by the Contractor's engineer working with the blast deflector manufacturer.

1.5 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained location, protected from damage, and easily accessible for inspection and handling.

PART 2 PRODUCTS

2.1 BLAST DEFLECTOR

Blast deflector shall be solid, curved corrugated sheet steel with horizontal corrugations.

2.2 HEAT-TREATED BOLTS

All bolts shall be of type SAE 1038 steel, heat-treated.

2.3 SELF-LOCKING NUTS

All nuts, except on anchor bolts, shall be of the all-steel, self-locking type to prevent loosening due to vibration.

2.4 FINISH

Finish shall be galvanized as indicated below. Abrasions and damage to the coating shall be touched up with a zinc rich primer.

2.4.1 Fasteners

All bolts, nuts, and washers shall be galvanized in accordance with ASTM A 153M.

2.4.2 Structural Steel

All structural members, excluding corrugated sheet metal, shall be galvanized in accordance with ASTM A 123M.

2.4.3 Corrugated Sheet Steel

Corrugated sheet steel shall be galvanized in accordance with AASHTO M 218.

PART 3 EXECUTION

3.1 INSTALLATION

Blast deflector shall be installed in accordance with approved detail drawings and manufacturer's specifications. All field connections shall be bolted connections. Under certain conditions of irregular terrain or pavement, holes may be reamed or re-drilled to facilitate assembly, but burning of holes or gas cutting on any part of the blast deflector is not permitted. Welds subject to tension or vibration and rivets shall not be used. Anchor bolts for anchorage to the foundation shall be standard with the manufacturer of the blast deflector.

3.2 TESTING

Prior to fabrication of the project required blast deflector, a full scale blast deflector prototype shall have been satisfactorily tested by the manufacturer. The tested prototype shall be the same approximate height and shape as the proposed blast deflector. The prototype width shall have been of sufficient width to establish that the blast is deflected at a forty-five degree angle above horizontal, from the top of the deflector. Blast deflector prototype construction shall have been essentially the same as that required for the in-service deflector with material types, thickness, structural properties, and finishes identical. Connections in the prototype shall be the same as the blast deflector provided. Blast deflector shall be tested under break-away and taxing power as described in the paragraph below. The engine shall be run-up and it shall be demonstrated by means of smoke-pot tests that smoke and gases are deflected at a forty-five degree angle above horizontal, from the top of the deflector, with no evidence of smoke dispersal behind deflector. Evidence of noxious exhaust gases behind deflector shall constitute a failure. Testing shall be the responsibility of the Contractor. The Government is under no obligation to provide testing facilities, jet engines, fuel or personnel to the Contractor for testing. No time extensions or changes in construction phasing will be made in this contract to accommodate testing prior to fabrication. The Contractor shall notify the Contracting Officer, 2 weeks prior to the testing, of the time and place of the testing and shall allow the Contracting Officer or his representative to witness any part of the testing procedure. At the Contractors option, certified test results from previous tests demonstrating adequate performance of similar blast deflectors subjected to the specified jet blast may be submitted for approval in lieu of testing.

Prior to final acceptance, the Jet Blast Deflector shall be field tested provided a C-5 or equivalent aircraft is available. The Contracting Officer will make arrangements and furnish the test aircraft. If a test aircraft is not available, the manufacturer's test results above will be used. The proposed field test sequence shall be performed by the Contractor, in the presence of the Contracting Officer and the Jet Blast Deflector manufacturer's representative in accordance with the following:

1. Inspect the Jet Blast Deflector (JBD) to be certain all nuts and bolts are in place and tightened to JBD manufacturers recommendations.
2. Inspect the area surrounding the JBD to be certain the area is free of FOD and safe for run-up operations.
3. Prepare the JBD for testing by attaching high visibility streamers to the discharge lip of the JBD at approximately 1.8m (6 foot) intervals. Smoke canisters should be wired near the top of the JBD rear struts, one canister should be placed in line with each engine to be operated at full power with additional canisters located approximately 3.65m (12 feet) to each side. Additionally a smoke canister should be set directly behind the operating engines at a distance of 3-4.5m (10-15 feet) at ground level, behind the deflector.
4. During the test it is important that clear communications be maintained between the cockpit crew and the JBD observers. In the event any perceived problem is observed, during the test the test shall be immediately terminated.
5. Align the aircraft centerline perpendicular to the JBD leading edge. No tail may be closer than 35 feet from the JBD leading edge and no engine nozzle may be closer than 60 feet from the JBD leading edge. Operation of the aircraft at distances closer than those stated above may void the JBD manufacturer's warranty.

NOTE: Aircraft operator to approve the following procedures prior to testing.

6. Start all engines and bring to idle power.
7. Bring engines to breakaway power long enough to observe streamers and smoke then taxi away from the JBD.
8. After the test is complete, a thorough walk around inspection of the JBD should be performed to be certain no abnormalities are noted. Upon completion, a full written report should be made by the representative of the JBD Manufacturer, with a copy to be retained by the Contracting Officer, and the General Contractor.

-- End of Section --

SECTION 16111

CONDUITS AND RACEWAYS
08/03

AMENDMENT 2

PART 1 GENERAL

This Section includes conduit and ductbank systems, fittings, supports and accessories that shall be provided as required and as shown on the Contract Drawings.

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Conduit, connectors, and associated; G, RE

A complete itemized listing of equipment and materials proposed for incorporation into the work. Data composed of catalog cuts, brochures, circulars, specs and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

PART 2 PRODUCTS

2.1 CONDUIT

In the text of these Specifications and the Contract Drawings, the words conduit and duct are used interchangeably and have the same meaning.

2.1.1 Rigid Steel Conduit (Rsc)

- a. Rigid metal conduit and couplings shall be galvanized steel, hot-dipped with zinc over the entire length, both exterior and interior including threads. In addition conduits shall have a coat of lacquer for sealing. RSC conduit shall meet ANSI Standard C80.1, latest revision.
- b. Each conduit shall be provided with a coupling on one end and a thread protector on the other.
- c. Provide threaded, galvanized steel or malleable iron fittings.
- d. The conduit shall be as manufactured by Allied Tube & Conduit Co. or approved equal. Manufacturer specified for quality only.

2.1.2 PVC Coated Rigid Steel Conduit

- a. PVC coated rigid steel conduit and fittings shall consist of a

rigid steel conduit with a PVC coating not less than 40 mils thick. The PVC coating shall be bonded to the conduit and fittings

- b. Rigid steel conduit shall be as specified above.
- c. The conduit shall be "Plasti-Bond Red" as manufactured by Robroy Conduit Co. or approved equal. Manufacturer specified for quality only.

2.1.3 Non-Metallic Conduits (PVC)

a. Non-metallic conduits and fittings shall be schedule 80 extra heavy wall polyvinyl chloride conduit. Refer to Power Circuit - Conductor and Conduit Schedule, shown on the Contract Drawings for type required.

1. Materials shall be corrosion, fire retardant and sunlight resistant.

b. Conduit and fittings shall be in accordance with NEMA Standard TC-2 and TC-3, latest revisions.

c. The conduit and fittings shall be as manufactured by Carlon Electric Conduit Co. or approved equal. Manufacturer specified for quality only.

2.1.4 Liquidtight Flexible Metallic Conduit (LFMC)

a. LFMC shall be galvanized steel core type, with oil resistant thermoplastic cover. Sizes 3/8 inch to 1-1/4 inch shall be provided with integral ground wire.

b. Provide steel, gasketed, insulated throat, compression type liquidtight fittings.

c. The conduit shall be type "UA" as manufactured by Anaconda Conduit Co. or approved equal. Manufacturer specified for quality only.

2.2 CONDUIT OUTLET BODIES, EXPANSION COUPLINGS

Sublevels below the third tier should not be used because they are not recognized by SpecsIntact software, but when necessary they should carry alpha designations (a, b, etc.). Sublevels below the third tier will not appear on the table of contents generated through SpecsIntact.]

2.2.1 Conduit Outlet Bodies

Conduit outlet bodies shall be used where required to permit ready fishing and withdrawing of wires. Bodies shall be of the cast iron or copper-free Aluminum type, gasketed.

Bodies shall be Condulet series manufactured by Crouse-Hinds Co. or approved equal. Manufacturer specified for quality only.

2.2.2 Expansion Couplings

a. Expansion couplings shall be a water-tight, corrosion resistant coupling with flexible neoprene outer jacket, stainless steel jacket clamp, flexible external copper ground strap, and internal hub bushing.

b. Coupling shall compensate for the following movements.

1. Axial expansion or contraction.
2. Angular misalignment.
3. Parallel misalignment.

c. Coupling shall be type XD as manufactured by Crouse-Hinds Company or approved equal. Manufacturer specified for quality only.

2.3 CONDUIT HANGERS AND SUPPORTS

a. Hangers and supports for conduits shall be adequate to support conduit systems with a minimum safety factor of 10.

b. Channel support steel shall be minimum 12 gauge, nominal 1-1/2 inch wide by 1-1/2 inch deep.

c. All steel parts of the conduit support systems shall be galvanized or cadmium plated.

d. Perforated strap hangers will not be accepted.

e. One hole malleable iron pipe clamps shall be hot dipped galvanized.

f. Hanger rods shall be continuous thread and galvanized not less than 3/8 inch in diameter.

2.4 MISCELLANEOUS ACCESSORIES

2.4.1 Fasteners

All fasteners shall be stainless steel or silicon bronze. All expansion anchors shall be self-drilling type, consisting of a shell and expander.

2.4.2 Pull Rope

Nylon rope having a minimum tensile strength of 200 pounds in each empty duct. Leave a minimum of 24 inches of slack at each end of the pull ropes

PART 3 EXECUTION

3.1 Installation

3.1.1 Specific Requirements

a. Schedule 80 PVC rigid type conduit shall be provided for all floodlighting, misc and taxiway and guidance sign lighting circuit conduits located below taxiway pavements.

b. PVC coated rigid steel conduit (concrete encased) shall be provided from Building #1611 to first existing manhole.

c. All conduits in Building #1611 shall be rigid steel (RSC).

EXCEPTION: Liquid-tight Flexible Metallic Conduit (LFMC) shall be used for wire conveyance at constant current regulators as shown on the Contract

Drawings.

3.1.2 General

Conduit is to be installed with a minimum number of joints. Terminations of all rigid steel conduits shall be furnished with locknuts at each cabinet, junction or pull box. Locknuts are not required where steel conduits enter threaded steel hubs.

Terminations of metallic conduits shall be furnished with grounding bushings in accordance with Section 16450; Electrical Grounding.

Where exposed conduit requires clamping to the building structure, clamps shall consist of galvanized iron one-hole pipe straps and appropriate type expansion shields.

All conduit fittings, connectors and couplings shall be properly tightened in such a manner so as not to be easily "backed off" in order that good ground continuity is established.

Support exposed enclosures and/or junction/pull boxes separately from building construction, not from conduit.

Conduit supports shall be spaced at intervals of 5 feet or less as required to obtain rigid construction.

Exposed conduits shall be installed parallel to or at right angles with lines of buildings in neat and organized configurations.

The number of bends, offsets and crossovers shall be kept to a minimum.

For bends made in the field, an approved conduit bending machine shall be used.

Field bends shall be symmetrical and carefully made so as to prevent damage or deformation of conduit.

Ream conduit ends before installation.

All conduit threads shall be given a coat of zinc dust in oil or other approved compound and shall be made up watertight.

Expansion joints shall be installed in conduits crossing buildings expansion joints.

Conduit runs shall be slightly pitched to facilitate draining condensation or shall be otherwise installed to prevent trapping of condensation.

The Contractor shall exercise the necessary precautions to prevent the lodging of dirt or foreign matter, in conduits, boxes and fittings during installations.

Plug conduit openings until wires are installed.

Where spare or empty conduits are shown to be installed, the conduit shall be provided with a nylon pull wire.

3.1.3 Underground Conduits

Concrete encased conduits shall be installed as specified herein and/or as shown on Contract Drawings, Ductbank Details.

The ductbank system shall be installed in a straight line except where change of direction is necessary, with a minimum slope of 3 inches in each 100 feet toward the existing manhole.

As each duct installation is completed, draw through each conduit, a flexible testing mandrel not less than 12 inches long and having a diameter 1/4 inches less than the inside diameter of the conduit through which it is drawn. Next, draw a stiff bristle metal brush through each conduit to make certain that no particles of earth, sand or gravel have been left in the conduit, plug conduits until conductors are installed.

Where empty conduits are shown to be installed, the conduit shall be provided with a nylon pull wire.

Underground conduits exiting and entering building structures shall have expansion couplings as required.

-- End of Section --

SECTION 16415A

ELECTRICAL WORK, INTERIOR
06/02

AMENDMENT 2

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM B 1 (1995) Hard-Drawn Copper Wire
- ASTM B 8 (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches
- NEMA OS 1 (1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

- UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment
- UL 486A (1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
- UL 486E (1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
- UL 489 (1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- UL 5 (1996) Surface Metal Raceways and Fittings
- UL 514A (1996; Rev Dec 1999) Metallic Outlet Boxes
- UL 514B (1997; Rev Oct 1998) Fittings for Cable and Conduit

UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 83	(1998; Rev thru Sep 1999) Thermoplastic-Insulated Wires and Cables
UL 877	(1993; Rev thru Nov 1999) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL Elec Const Dir	(1999) Electrical Construction Equipment Directory

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 NOT USED

2.2 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.2.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2.2.2 NOT USED

2.2.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.2.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.3 NOT USED

2.4 NOT USED

2.5 NOT USED

2.6 CIRCUIT BREAKERS

2.6.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2.6.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper and aluminum conductors in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.6.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.7 NOT USED

2.8 CONDUIT AND TUBING

2.8.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

2.8.2 NOT USED

2.8.3 NOT USED

2.8.4 NOT USED

2.8.5 NOT USED

2.8.6 NOT USED

2.8.7 NOT USED

2.8.8 NOT USED

2.8.9 NOT USED

2.8.10 Surface Metal Electrical Raceways and Fittings

UL 5.

2.9 CONDUIT AND DEVICE BOXES AND FITTINGS

2.9.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

2.9.2 NOT USED

2.9.3 NOT USED

2.9.4 NOT USED

2.9.5 Fittings for Conduit and Outlet Boxes

UL 514B.

2.10 NOT USED

2.11 CONNECTORS, WIRE PRESSURE

2.11.1 For Use With Copper Conductors

UL 486A.

2.12 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

PART 3 EXECUTION

3.1 NOT USED

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in electrical metallic tubing. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as

described in paragraph WIRING METHODS. Minimum size of raceways shall be 15 mm. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit and tubing may be used in damp, wet or corrosive locations when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Aluminum conduit may be used only where installed exposed in dry locations. Nonaluminum sleeves shall be used where aluminum conduit passes through concrete floors and firewalls. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 150 mm away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 15 meters in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 45 meters in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 1.4 MPa (200 psi) tensile strength. Not less than 254 mm of slack shall be left at each end of the pull wire.

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 150 mm above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 NOT USED

3.2.1.4 NOT USED

3.2.1.5 NOT USED

3.2.1.6 Supports

Metallic conduits and tubing, and the support system to which they are

attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 3 meters and within 900 mm of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

3.2.2 NOT USED

3.2.3 NOT USED

3.2.4 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3.2.4.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 30 meters long and of 277 volts more than 70 meters long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy,

remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.4.2 NOT USED

3.2.4.3 NOT USED

3.2.4.4 NOT USED

3.2.4.5 Cable Splicing

3.2.4.6 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).

277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).

120/240-volt, 1-phase: Black and red.

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 75 mm of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.

- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 1.2 meters above finished floors.

Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 600 mm. The total combined area of all box openings in fire rated walls shall not exceed 0.0645 square meters per 9.3 square meters. Maximum box areas for

individual boxes in fire rated walls vary with the manufacturer and shall not exceed the maximum specified for that box in UL Elec Const Dir. Only boxes listed in UL Elec Const Dir shall be used in fire rated walls.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces, or when located in hazardous areas. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 102 mm square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 2.4 mm wall thickness are acceptable. Large size boxes shall be NEMA 1 or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 38.1 mm (1-1/2 inches) into reinforced-concrete beams or more than 19.1 mm (3/4 inch) into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 25 mm long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 300 mm long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 6 mm from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall

be readily removable for access to the boxes unless ceiling access panels are provided.

3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 600 mm from the box.

3.4 NOT USED

3.5 NOT USED

3.6 NOT USED

3.7 NOT USED

3.8 NOT USED

3.9 NOT USED

3.10 NOT USED

3.11 NOT USED

3.12 NOT USED

3.13 NOT USED

3.14 NOT USED

3.15 NOT USED

3.16 NOT USED

3.17 NOT USED

3.18 NOT USED

3.19 NOT USED

3.20 NOT USED

3.21 NOT USED

3.22 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed,

personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.22.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.22.2 NOT USED

3.22.3 NOT USED

3.22.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 304.8 / (\text{length of cable in meters})$

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.22.4.1 NOT USED

3.22.4.2 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

3.22.5 NOT USED

3.22.6 NOT USED

3.22.7 NOT USED

3.22.8 NOT USED

3.22.9 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.22.9.1 NOT USED

3.22.9.2 NOT USED

3.22.9.3 Circuit Breakers, Molded Case

- a. Insulation resistance test phase-to-phase, all combinations.

- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker.

-- End of Section --

SECTION 16450

GROUNDING

08/03

Amendment 2

PART 1 GENERAL

This Section contains the grounding system conductors, rods, connectors and accessories that shall be provided as required and as shown on the Contract Drawings.

1.1 REFERENCES

The publication listed below, current as of the date of this solicitation, forms a part of this specification to the extent referenced. The publication is referred to in the text by basic designation only.

National Fire Protection Association (NFPA) - NFPA 70 National
Electric Code

NFPA 70, Article 250 Grounding

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Protection System; G, RE

Detail drawings consisting of a complete list of equipment and material, manufacturer's descriptive and technical literature, catalog cuts, wiring diagrams, and installation instructions. Drawings shall demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts.

SD-06 Test Reports

Testing and Inspection; G, RE

Test data in booklet form, upon completion of installation of the system. The test report shall document all field tests performed and shall verify compliance with the specified performance criteria. Test data shall include the make, model and serial number of instruments used to conduct the test, and a certificate from an approved independent testing laboratory of meter calibration performed within 12 months of test.

1.3 Definitions

- a. Earth: Shall be interpreted as absolute ground, a theoretical location of zero electrical potential.
- b. Ground: Shall be interpreted as a made conducting connection to earth by employing such devices as a driven metal rod, a buried metal plate, a metallic water pipe, etc. or any multiple and/or combination of these devices and the conductors which may interconnect any of the foregoing.
- c. System Ground: Shall be interpreted as a low impedance connection to ground, established for the benefit of a particular electrical system or related system.

1.4 Description Of System

It is the intent of this Section of these Specification to require that all grounding and grounding circuitry equal or exceed the requirements of NFPA 70 Article 250 and in the event of a conflict or discrepancy between these Specifications, the Contract Drawings and NFPA 70 Article 250, the more stringent requirement shall apply.

The raceway system which includes all metal conduit, wireways, pull boxes, junction boxes, built up enclosures, etc. shall be made to form a continuous, conducting, permanent ground circuit of the lowest practical impedance to enhance the safe conduction of ground fault currents and to prevent objectionable differences in voltage between metal and non-load current carrying parts of the electrical system.

Maximum resistance between "Earth" and "System Ground" as previously defined shall not exceed 5 ohms.

Each element of the ground system shall:

Resist fusing and deterioration of electrical joints under the most severe fault current condition.

Be mechanically rugged especially in locations where they are exposed to physical damage.

Have sufficient conductivity so that it will not contribute to dangerous local potential differences.

PART 2 PRODUCTS

2.1 CONDUCTORS

Grounding conductors used in conjunction with a raceway system shall be of the insulated type and color shall be as specified in Paragraph 2.08 A, below.

All exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc. shall be bare copper.

Cable size shall be as required by NFPA 70 Article 250, stranded soft drawn or annealed copper, unless otherwise shown on the Contract Drawings.

2.2 COUNTERPOISE SYSTEM CONDUCTORS

Counterpoise system conductors shall be minimum size #4 AWG bare stranded

copper. Connections shall be made with irreversible compression connectors, similar to Burndy Hygound type, unless as otherwise indicated. Manufacturer specified for quality only.

2.3 GROUNDING ELECTRODES

Ground rods shall be 3/4 inches in diameter, minimum 8 feet long unless otherwise shown, steel core with copper with copper molten welded or electrolytically bonded to exterior.

Make: Copperweld Steel Co. or approved equal. Manufacturer specified for quality only.

2.4 CONNECTORS, CLAMPS, TERMINALS

Mechanical connectors and clamps shall be silicon bronze. Grounding system connections shall be made with compression type connectors, unless as specified or as indicated on the Contract Drawings for exothermic reaction weld process connectors. Solderless compression terminals shall be copper, long barrel, one hole for conductor sizes #8 AWG thru #1/0 AWG, two hole for all larger sizes. Counterpoise grounding connectors shall be irreversible compression type. Make: Burndy or approved equal. Manufacturer specified for quality only.

2.5 SOLDER

Solder is prohibited for connections.

2.6 EXOTHERMIC REACTION WELDING PROCESS CONNECTORS

Process shall be Cadweld or approved equal. Manufacturer specified for quality only.

2.7 HARDWARE

All hardware shall be silicon bronze alloy.

Make: Durium or approved equal. Manufacturer specified for quality only.

2.8 EQUIPMENT GROUND CONDUCTORS

Equipment ground conductors shall be in accordance with Section 16120 for low voltage conductors.

Ground conductor #8 AWG and smaller shall be green in color.

For #6 AWG and larger ground conductors, black wire may be used and identified where exposed in all J-boxes, disconnect switches, enclosures, etc. with green tape wrapped over its entire exposed length.

PART 3 EXECUTION

3.1 GENERAL

Cables, fittings, etc. shall not be installed in cinder fill nor shall be covered with soil containing cinders or other corrosive material. Cables shall be installed with enough slack to prevent breaking stresses. All grounding conductors subject to mechanical damage shall be protected by rigid steel conduit or other suitable steel guards and in all cases where

so protected shall be permanently and effectively grounded to conduit and/or guard at each end of its length, unless otherwise indicated.

Where grounding conductors pass through floor slabs, walls, etc., and are not encased in metal conduit, they shall be sleeved in transite, fiber, or approved nonmetallic conduit. Connections to water pipes, including water meter or other similar device bypass connections, shall be made only after the surface of the pipe at the point of connection has been thoroughly cleaned and brightened and immediately prior to actually making the connection the contact surfaces are to be coated with Vaseline or Oxidation Preventive Compound.

All equipment ground bus, ground pads, frames, enclosures, etc. shall have surfaces at point of connection thoroughly cleaned and brightened just prior to actually making the connection. Touch-up damaged painted surfaces. Splices in wire or cable grounding conductors are prohibited.

3.2 COUNTERPOISE GROUNDING SYSTEM

Counterpoise Installation. Lay counterpoise wire for the entire length of the new conduit system supplying the taxiway centerline and edge lighting equipment. Provide wire in one piece, except where distance exceeds the length usually supplied and install along the envelope of concrete encased conduit. Counterpoise cable splices shall be made with irreversible compression type connectors. Interconnect the new counterpoise system to the existing counterpoise at the location shown on the Contract Drawings. The counterpoise shall be connected with irreversible compression type connectors to each ground rod as shown on the Contract Drawing Detail. Each airport light base shall be connected to the counterpoise at external ground lug. Attach with copper ground clamp #0919.

3.3 GROUNDING ELECTRODES

Grounding electrodes shall be installed at a minimum of 500 feet apart along the entire counterpoise system. The counterpoise system grounding electrodes shall be driven straight down, perpendicular to the finished grade so that the top of the electrode is below grade as shown on the Contract Drawings, Buried Conduit Typical Trenching Detail Within Taxiway and shall meet the requirements of NFPA 70 Article 250-58.

3.4 GROUNDING SYSTEM CONNECTIONS

Exposed connections shall be made with compression type connectors. Connections between different metals shall be protected against corrosion and moisture with an insulating epoxy resin. Ground terminals or lugs shall be provided in each enclosure, equipment, etc.

3.5 CONDUIT SYSTEM

Ground Conductor. All conduits installed in Bldg. #1611 (power and control circuits, etc.) shall have an internal grounding conductor which shall be sized in accordance with the requirements of the NEC, this ground conductor shall be installed although it may not be shown or scheduled on the Contract Drawings. The internal grounding conductor shall be bonded to each device box, pull box, junction box, or wiring trough it passes through.

All metal conduits 1 inch and larger shall be provided with grounding bushings on each end and at all cabinets and pull, junction, or outlet boxes. The Contractor shall exercise care to ensure good ground continuity, in particular, between the conduit system and equipment frames

and enclosures.

3.6 HANDHOLES

Handholes shall be as indicated. Strength of handholes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete handholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48A, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 69 MPa (10,000 psi) and a flexural strength of at least 34.5 MPa (5000 psi). Pullbox and hanhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

3.6.1 General

Handholes shall be constructed approximately where shown. The exact location of each handhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each handhole shall be approved by the Contracting Officer before construction of the handhole is started. Handholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. All duct lines entering handholes must be installed on compact soil or otherwise supported when entering a handhole to prevent shear stress on the duct at the point of entrance to the handhole. Duct lines entering cast-in-place concrete handholes shall be case in place with the handhole. Duct lines entering precast concrete handholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast handholes through a PVC endbell shall be solvent welded to the endbell. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

3.6.2 3.6.2 Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown on plans.

3.7 TESTING

Acceptance. The Contractor shall test the counterpoise system and all grounding conductors for continuity. The continuity shall be measured using an ohmmeter or equivalent continuity tester. Where continuity does not exist, jumpers shall be installed at no cost to the Government and the system retested. All testing shall be performed in the presence of the COTR.

-- End of Section --

SECTION 16560

AIRFIELD LIGHTING

08/03

AMENDMENT 2

PART 1 GENERAL

Inset taxiway centerline and edge light fixtures, airport light bases, isolation lighting transformers, constant current regulators, all accessories, controls and tests required for the complete installation of the taxiway centerline and edge lighting systems and the upgrade to the existing airfield lighting control system as shown on Contract Drawings and specified herein.

1.1 QUALITY ASSURANCE

Do not use askarel, tetrachloroethylene and insulating liquids containing polychlorinated biphenyls (PCBs) in equipment.

Provide submersible type equipment installed below grade in airport light bases, handholes, manholes, etc.

Prior to installation of any light fixtures, the Contractor shall provide one sample inset taxiway centerline light fixture installation and one sample inset taxiway edge light fixture installation. The sample installations shall include all components and materials as noted on the typical taxiway centerline and edge light installation details shown on the Contract Drawings. The Contracting Officer will direct the Contractor as to the location for the sample installations and will approve or make minor modifications to the installation details as he deems necessary. The approved installation details shall be the method used to install each type of taxiway inset light fixtures at no additional cost to the Government. The Contractor shall remove these samples in their entirety after the new lighting systems are installed or when directed by the Contracting Officer.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lighting and Navigation Aids]; G, RE

Coordination drawings consisting of composite drawings showing coordination of work of one trade with that of other trades and with the structural and architectural elements of the work. Drawings shall be in sufficient detail to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Drawings shall indicate where conflicts or clearance problems exist between the various trades.

As-Built Drawings; G, RE

Drawings that provide current factual information including deviations from, and amendments to the drawings and changes in the work, concealed and visible, shall be provided as instructed. The as-built drawings shall show installations with respect to fixed installations not associated with the systems specified herein. Cable and wire shall be accurately identified as to direct-burial or in conduit and shall locate the connection and routing to and away from bases, housings, and boxes.

Lighting System; G, RE

Detail Drawings; G, RE

Detail drawings for the complete system and for poles, lighting fixtures, bracket arms, cages, and handholes.

Include dimensions, effective projected area EPA, accessories, pad installation, and construction details. Photometric data, include zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

Floodlight Pole Design; G, RE

The design of the Apron floodlight pole shaft, pole base, anchor bolts and associated shall be designed for the effects of a wind, service, and dead load as determined in accordance with ASCE 7-98.

The design for the pole shaft, pole base, anchor bolts and associated shall be sealed by a qualified licensed engineer.

SD-03 Product Data

Materials and Equipment; G, RE

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each itemization shall include an item number, the quantity of items proposed, and the name of the manufacturer. Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

Protection Plan; G, RE

Detailed procedures to prevent damage to existing facilities or infrastructures. If damage does occur, the procedures shall address repair and replacement of damaged property at the Contractor's expense.

Training; G, RE

Information describing training to be provided, training aids to be used, samples of training materials to be provided, and schedules of training, 3 weeks before training is scheduled to begin.

Special Tools; G, RE

List of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

Parts; G, RE

A list of parts and components for the system by manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delays.

Repair Requirements; G, RE

Instructions necessary to check out, troubleshoot, repair, and replace components of the systems, including integrated electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting after acceptance of the system shall be provided.

Posted Instructions; G, RE

A typed copy of the proposed posted instructions showing wiring, control diagrams, complete layout and operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting.

SD-06 Test Reports

Field Quality Control; G, RE

Upon completion and testing of the installed system, performance test reports are required in booklet form showing all field tests performed to adjust each component and all field tests performed to provide compliance with the specified performance criteria. Each test shall indicate the final position of controls.

Field test reports shall be written, signed and provided as each circuit or installation item is completed. Field tests shall include resistance-to-ground and resistance between conductors, and continuity measurements for each circuit. For each series circuit the input voltage and output current of the constant current regulator at each intensity shall be measured. For multiple circuits the input and output voltage of the transformer for each intensity setting shall be measured. A visual inspection of the lights operation, or of the markings appearance, or of the installation of fixtures or units installed shall be reported.

Inspection; G, RE

Inspection reports shall be prepared and provided as each stage of installation is completed. These reports shall identify the activity by contract number, location, quantity of material placed, and compliance with requirements.

SD-07 Certificates

Welding; G, RE

Cables, General Requirements; G, RE

Certifications, when specified or required, including Certification of the Qualifications of Medium-Voltage Cable Installers, Certified Factory and Field Test Reports, and Certificates of Compliance submitted in lieu of other proofs of compliance with these contract provisions. A certification that contains the names and the qualifications of persons recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract shall be included. The certification shall indicate that any person recommended to perform actual splicing and termination has been adequately trained in the proper techniques and has had at least 3 recent years of experience in splicing and terminating the same or similar types of cables approved for installation. Any person recommended by the Contractor may be required to perform a dummy or practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types. The certification shall be prepared in conformance with paragraph CERTIFICATES OF COMPLIANCE in the SPECIAL CONTRACT REQUIREMENTS, and shall be accompanied by satisfactory proof of the training and experience of persons recommended by the Contractor as cable installers. The SF sub 6 gas pressurized cable and conduit system installer must be trained and certified in installation of this type of system and must be approved by the manufacturer of the system.

Materials and Equipment; G, RE

When equipment or materials are specified to conform to the standards or publications and requirements of AASHTO, ANSI, ASTM, AEIC, FM, IEEE, IES, NEMA, NFPA, or UL, or to an FAA, FS, or MS, proof that the items furnished under this section of the specifications conform to the specified requirements shall be included. The label or listing in UL Elec Const Dir or in FM P7825a, FM P7825b or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards, or publications and with the manufacturer's standards will be acceptable evidence of such compliance. Certificates shall be prepared by the manufacturer when the manufacturer's published data or drawings do not indicate conformance with other requirements of these specifications.

SD-10 Operation and Maintenance Data

Equipment; G, RE

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set shall be furnished prior to performance testing and the remainder shall be furnished upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model

number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include conduit and equipment layout and simplified wiring and control diagrams of the system as installed.

PART 2 PRODUCTS

2.1 AIRFIELD LIGHTING CABLE

Compliance - FAA AC-150/5345-7, refer to Section 16120.

2.2 CONNECTORS (AIRFIELD CABLE PRIMARY CONNECTOR KIT)

Compliance - FAA AC-150/5345-26, refer to Section 16120.

2.3 ENCAPSULATED ISOLATING TRANSFORMERS

Compliance - FAA AC-150/5345-47, Type L-830-1 for 30/45 watt transformers. Rubber encapsulated, two primary leads with plug and receptacle, one secondary lead with two wire receptacle. Provide each transformer with nominal wattage size, 6.6 amp primary, 6.6 amp secondary current ratings, to meet the requirements of each taxiway centerline and edge light fixture provided or as shown on the Contract Drawings.

2.4 AIRPORT LIGHT BASES

Compliance - FAA AC-150/5345-42

Type L-868, Class 1, Size B, 24 inch deep, with 2 inch base grommet openings.

Each base shall be provided with external ground lug, each lug shall be provided with a copper ground clamp #0919.

Light bases with two 2 inch grommet openings @ 0°-180° shall be part #AC2424-2Q. Bases with three 2 inch grommet openings @ 0°-90°-180° shall be part #AC2424-3Q. Bases with four 2 inch grommet openings @ 0°-90°-180°-270° shall be part #AC2424-4Q.

It shall be the responsibility of the Contractor to provide light bases with 2 inch grommet openings to facilitate the light fixture alignment and conduit configuration of the edge and centerline lighting systems and conduits as shown on Contract Drawings. If light bases are required with grommet openings that are not standard items normally supplied by the manufacturer, provide bases with special angle grommet openings as required to insure proper base alignments.

2.4.1 Accessories

Taxiway centerline bases shall be provided with a 3/4-inch thick flange ring (with O-ring) as required to accommodate installation of inset fixtures or cover plates specified. Bolts and lock-washers shall be stainless steel. Flange ring shall be part #5402-12Y as manufactured by Jaquith Industries Inc. Manufacturer or approved equal (specified for quality only).

Each airport light base installed without a fixture shall be provided with

a blank 3/4-inch thick steel cover plate. Bolts and lock-washers shall be stainless steel. Cover plates shall be part #4000-12 as manufactured by Jaquith Industries Inc. Manufacturer or approved equal (specified for quality only).

2.5 TAXIWAY/RUNWAY GUIDANCE SIGNS (LIGHTED)

Compliance - FAA AC-150/5345-44 and 44F, Class 2, Size 3, Style 3.

Provide single and double face lighted signs for frangible mounting on concrete pads as shown on the Contract Drawings (Taxiway/Runway Guidance Sign Schedule). Type L-858Y for direction, destination, information and boundary signs - (black legend on a yellow background), Type L-858R for mandatory instruction signs - (white legend on a red background) and Type L-858L for taxiway and runway location signs - (yellow legend on a black background). The blank panel of single face signs shall be a (black opaque panel).

The minimum height of inscriptions on information signs shall 5 inches.

Construction - Signs shall be modular type, with uniform leg spacing and shall be factory assembled and wired in up to four module lengths. Sign frames shall consist of aluminum extrusions (top and base) and aluminum castings (end panel and inter-modular part). The tops of signs shall be removable for easy re-lamping and shall be secured with turn fasteners. Legends shall be applied on the inside surface of curved acrylic plastic and shall be backed with retro reflective, translucent sheeting. All required mounting hardware shall be provided with signs.

Electrical - Each single module or multi module sign shall be factory wired and provided with:

1. One power input cable with a L-823 plug for connection to the isolation transformer secondary. Cable length shall permit plug end to reach at least 6 inches below top of concrete pad on which the sign is mounted.
2. Lamps shall be series connected, provide two 45W EXM quartz lamps per module.
3. External power disconnect switch, which de-energizes all electrical connections to the sign for safe sign maintenance.
4. Lamp bypass circuit to maintain reduced illumination upon failure of one lamp.

Swing-away of hinged-type signs are unacceptable.

Taxiway/runway guidance signs shall be Lumacurve Type, as manufactured by Standard Signs, Inc. Manufacturer or approved equal (specified for quality only).

2.6 TAXIWAY EDGE LIGHTS

Provide flush inset taxiway edge light fixtures and associated equipment and interconnecting wiring for a complete system as shown on the Contract Drawings and specified herein.

2.6.1 Taxiway Edge (Straight Sections)

Compliance - FAA AC-150/5345-46B, Style 3 Series, Type L-852T. Fixtures shall omni-directional, blue. Each fixture shall be provided with one isolation transformer rated at 30/45 watts nominal, 6.6 amps primary, 6.6 amps secondary and one 45 watt pre-focussed tungsten halogen lamp. Install fixtures so that with no part of the fixture protrudes more than .110 inches above finished grade (taxiway).

Each fixture shall be provided with a factory mated 3/4 inch thick, 12 inch to 8 inch adapter ring (with O-ring) as required to accommodate the installation of the 8 inch diameter inset fixture to a 12 inch diameter light base. Bolts and lock-washers shall be stainless steel.

Fixture shall have a minimum three-year warranty against leakage.

Fixtures shall be type FFU, Style 3 Series, L-852T as manufactured by ERNI Airlight Inc. Manufacturer or approved equal (specified for quality only).

2.6.2 Taxiway End (Intersections ³ 1200RVR)

Compliance - FAA AC-150/5345-46B, Style 3 Series, Type L-852E. Fixtures shall omni-directional, yellow. Each fixture shall be provided with one isolation transformer rated at 30/45 watts nominal, 6.6 amps primary, 6.6 amps secondary and one 45 watt pre-focussed tungsten halogen lamp. Install fixtures so that with no part of the fixture protrudes more than .110 inches above finished grade (taxiway).

Each fixture shall be provided with a factory mated 3/4 inch thick, 12 inch to 8 inch adapter ring (with O-ring) as required to accommodate the installation of the 8 inch diameter inset fixture to a 12 inch diameter light base. Bolts and lock-washers shall be stainless steel.

Fixture shall have a minimum three-year warranty against leakage.

Fixtures shall be type FFU, Style 3 Series, L-852E as manufactured by ERNI Airlight Inc. Manufacturer or approved equal (specified for quality only).

2.7 LAMPS

Lamp wattage shown for each lighting fixture specified are recommended by the manufacturer listed. All taxiway fixture lamps shall be tungsten halogen type rated for 1000-hour minimum use, at wattages specified herein.

Fixtures shall be provided with lamp sizes to meet the photometric requirements for taxiway centerline lighting as defined in AFM 32-1076 and shown on the Contract Drawings.

2.8 CONSTANT CURRENT REGULATOR (CCR)

Compliance - FAA AC-150/5345-10, Type L-828, Oil Cooled, 60 hertz, single-phase 2,400 input volts, sized as shown on plans.

Provide one Type L-828, Oil Cooled, 15kW unit, to power three precision output current levels (6.6 amps maximum) with control, for the taxiway centerline series lighting circuit as shown on the Contract Drawings and specified herein.

2.8.1 Control requirements:

Remote ON/OFF control and three-step intensity.

Remote control of regulators shall be by 120-volt remote control signals.

The regulator shall be capable of operation on local control without the remote control cable connected and shall be capable of local operation for emergency if the remote switch or leads become inoperative.

2.8.2 Typical features and characteristics:

Free standing, floor mounting

Input voltage compensation for -5 to + 10% variation

Integral oil primary switch

Liquid-immersed saturable reactor type regulator

Three step intensity - 10, 30 and 100% of full intensity.

Minimum power factor - 95%.

Minimum overall efficiency - 90%.

Built-in true rms-reading ammeter $\pm 2\%$

Output current level - maintained within $\pm 1\%$ at any intensity level.

On-off switching - under any load.

Local/Remote selector switch.

Overcurrent, open circuit, undervoltage protection

Output lighting and transient protection

Regulators shall be type FAA type L-828 as manufactured by Flight Light Inc. Manufacturer or approved equal (specified for quality only).

PART 3 EXECUTION

3.1 GUARANTEE

The Contractor shall leave the entire Apron / Taxiway lighting systems in proper working order and for a period within one (1) year from the date of final approval by the Contracting Officer, shall without additional charge, replace any work, materials or equipment, furnished by him under this Contract which develops failures, resulting from poor work performance, or defective materials and equipment.

3.2 VISUAL EXAMINATION

Visual inspections shall be made frequently during installation, at completion of installation and before energizing circuits. Careful visual inspections may reveal defects that should be corrected before acceptance tests and energization. Visual inspections shall include:

1. Receipt of equipment for shipping damage.
2. Correctness of external connections.
3. Good workmanship.

4. Cleanliness.
5. Safety hazards.
6. Specific requirements listed below.

3.2.1 Isolation Transformer Inspections

Prior to installation provide visual inspection of factory installed molded primary and secondary connectors for minor cuts bruises.

During installation provide visual inspection for the following:

- a. The mating surfaces of molded connectors are clean and dry when plugged together. Two or three turns of electric tape shall be used to hold connectors together and keep the parting line clean. Cleanliness of mating surfaces can be ensured by keeping the factory installed connector caps in place until the final connection is made.
- b. The mating surfaces of uncapped connectors shall not be laid down, touched or breathed upon. If connection must be broken the connector shall be immediately capped.
- c. For final connection, plug connectors together after initial plugging, trapped air pressure may partially separate the plug and receptacle, if this happens wait a few seconds and push the connectors together again. Provide heat shrink kit over the parting line to prevent subsequent loosening of joint.

3.2.2 Cable Inspections

During installation provide visual inspection for the following:

- a. Cuts, kinks, bruises or damage of any kind that may occur during handling and installation.
- b. Sharply bent cables where they enter (or leave) a conduit, handhole, or manhole and that cables are supported properly.

3.2.3 Constant Current Regulator Inspections

Prior to installation provide visual inspection for shipping damage.

Provide all other inspections as may be defined in the Instruction Manual provided by the manufacturer.

3.3 CONSTANT CURRENT REGULATOR INSTALLATIONS

The constant current regulator shall be floor mounted in Building #1611 and installed per Instruction Manual provided by the manufacturer, Contract Drawings and as specified herein.

The services of the manufacturer's qualified Engineer shall be required for the inspection, tests and start-up, as outlined in the Instruction Manual provided by the manufacturer and as normally conducted and required for this class of equipment.

If for any reason i.e. low megger readings, high ohm readings, faulty regulator voltage or current output readings, it shall be the Contractor's responsibility to provide a quality regulator that actually energizes the

taxiway centerline and edge lighting circuits as designed.

3.4 3.4 ELEVATED AIRFIELD AND HELIPORT LIGHTS

Elevated lights shall be frangibly mounted, not to exceed 350 mm in height except where higher mounting is permitted in snow accumulation areas. Equipment exceeding 350 mm in height shall be frangibly mounted as indicated.

3.5 SEMIFLUSH AIRFIELD AND HELIPORT LIGHTS

Water, debris, and other foreign substances shall be removed prior to installing semiflush light base and light. Positioning jigs shall be used to hold the light bases and/or lights to ensure correct orientation and leveling until the concrete, adhesive, or sealant can provide permanent support.

3.6 GROUNDING SYSTEMS

Counterpoise Installation. Counterpoise wire shall be laid for entire length of circuits supplying airfield lighting. Wire shall be in one piece, except where distance exceeds the length usually supplied. Counterpoise shall be installed on top of the envelope of concrete-encased or sand-encased duct and approximately 150 mm above direct burial cables and duct lines. Where trenches or duct lines intersect, counterpoise wires shall be electrically interconnected by exothermic welding or brazing.

3.7 MARKING AND LIGHTING OF AIRWAY OBSTRUCTIONS

Towers, poles, smokestacks, buildings of certain shapes and sizes, and other obstructions shall be marked and lighted in accordance with FAA AC 70/7460-1 and as indicated in or required otherwise.

3.7.1 Painting of Airway Obstructions

Patterns and colors to mark obstructions shall conform to FAA AC 70/7460-1 and shall be as indicated.

3.8 RUNWAY AND TAXIWAY LIGHTING SYSTEMS

Runway and Taxiway Edge Lights. Edge lights shall be elevated type lights except in paved areas where semiflush lights are required. Threshold and runway end lights shall be semiflush type as indicated on the contract drawings. Elevated lights shall be frangibly mounted and each light supplied power through an isolation transformer. The taxiway lights shall be omnidirectional and only require leveling. The runway lights require leveling and alignment of the beams for the correct toe-in of the beams.

3.9 TESTING

3.9.1 General

All tests shall be performed in the presence of the CO and COTR.

The CO shall be given written notice 5 days prior to each test.

The Contractor shall furnish all necessary test equipment instruments.

Manufacturers data on testing resistance shall be submitted with tabulated

results.

If damage is indicated during testing or upon review of tabulated data, the Contractor shall replace defective wire and cables and retest at no cost to the Government.

Correct deficiencies found and repeat tests.

3.9.2 Progress Testing

Conduct a megger test on each section of circuit or progressive combinations of sections as they are installed. Check each section or progressive combination of sections with a megohm meter providing a voltage of approximately 1000 volts to provide a direct reading in resistance, and document results. Locate any faults indicated by these tests and eliminate before proceeding with the circuit installation.

3.9.3 Electrical Acceptance Tests

Perform acceptance tests for series lighting system circuit, only on completed lighting circuit. Subject series lighting circuit to a continuity test, megger test and high voltage insulation resistance test.

3.9.4 Continuity Test

Provide ohmmeter or equivalent continuity test for series circuit for electrical continuity.

3.9.5 Megger Test

Provide megger test for circuit to make sure it is free of grounds. Megger circuit with a megohm meter providing a voltage of approximately 1000 volts to provide a direct reading in resistance, and document results. Locate faults indicated by this test and eliminate before proceeding with the high voltage insulation resistance test.

3.9.6 High Voltage Insulation Resistance Test

Subject series lighting circuit to a high voltage insulation resistance test by measurement of the insulation leakage current. Provide a suitable high voltage test instrument that has a steady, filtered direct current output voltage and limited current. High voltage tester shall include an accurate voltmeter and microammeter for reading voltage applied to the circuit and resultant insulation leakage current. Do not apply voltages in excess of test values specified below.

Test Procedure: Disconnect both leads from regulator output terminals and support so that air gaps of several inches exist between bare conductors and ground. Clean and dry cable sheaths, for a distance of 1 foot from ends of cables and exposed insulation at ends of cables. Connect ends of both conductors of the circuit together and to high-voltage terminals of test equipment, and apply test voltage specified in the following tabulation between conductors and ground for a period of 5 minutes.

Test Voltage, dc		
	First Test on New Circuits	Test on Existing Circuits
Lighting Circuits		
Complete Taxiway Centerline & Edge Systems (5000-volt leads, 30/45 watt transformers)	6000	3000

When additions are made to existing circuits, test only new sections in accordance with "First Test on New Circuits" in table above. To ensure reliable operation, test complete circuit at reduced voltages indicated above.

Leakage Current: Measure and record insulation leakage current in microamperes for each circuit for each minute application of test voltage. Do not exceed the value of the insulation leakage current calculated on the basis of the following leakage current allowances for cable and connected equipment for each circuit:

3 microamperes for each 1000 feet of cable.

2 microamperes for each 30/45, 5000 volt series transformer.

Note: The above values include allowances for the normal number of connectors and splices.

3.9.7 Counterpoise System Test and Inspection

Continuity of counterpoise system shall be visually inspected at accessible locations. Continuity of counterpoise system to the vault grounding system shall be tested in manhole closest to the vault.

3.9.8 Operating Test

After installation has been completed, conduct an operating test. Demonstrate equipment to operate in accordance with the requirements of this Section. Conduct tests 1 day and 1 night for the Contracting Officer.

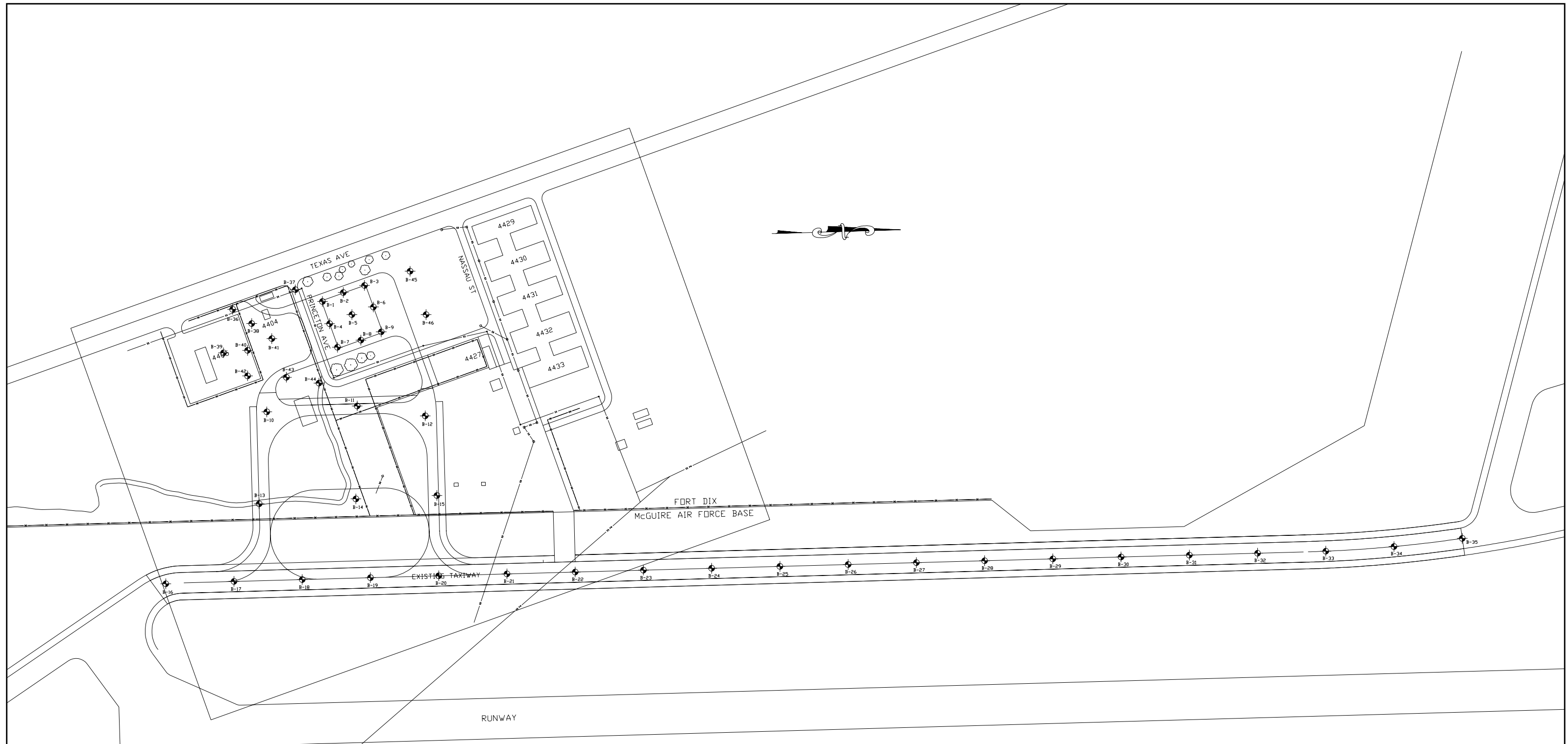
After all components and circuits have been inspected and tested as specified herein, show by demonstration in service, that the circuits, control equipment and lights covered by the Contract are in good operating condition. Operate each interface device on the airfield control tower lighting control interface panel, so that each control position is engaged at least twice. During this process, observe lights and associated equipment to determine that each interface device controls properly the corresponding circuit. Provide telephone or radio communication between the operator and observers.

Repeat tests from the remote control panel and from the local control switches on the constant current regulators located in building #1611.

Test the taxiway centerline and edge circuits by operating the lamps at maximum brightness for at least 6 hours. Visually examine at the beginning and at the end of this test to ensure that the correct number of lights are burning at full brightness. Dimming of some or all of the lights in a

circuit is an indication of grounded cables. In addition, measure the lamp terminal voltage on at least one light in the circuit to determine that it is within $\pm 5\%$ of the rated lamp voltage marked on each lamp.

-- End of Section --



DRAWING NOTES:

A) BORING LOCATION PLAN DERIVED FROM MASON & HANGER GROUP PROVIDED DRAWING.
FILENAME FOR PROVIDED DRAWING: FDAP_C-AF01V7.DWG

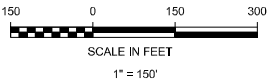
B) BORING LOCATION PLAN PROVIDED BY GEOTECHNICAL SUBCONSULTANT:
FRENCH & PARELLO ASSOCIATES
670 NORTH BEERS STREET, BLDG 3
HOLMDEL, NEW JERSEY 07733

C) BORING LOCATION PLAN SERVES AS SUPPLEMENT TO 03/26/2003 EXHIBIT 44 SUBMISSION IN ACCORDANCE WITH APPENDIX E OF THE LOUISVILLE DISTRICT CORPS OF ENGINEERS DESIGN GUIDE.

BORING #	DEPTH (FT.)	BORING #	DEPTH (FT.)
B-1	30	B-21	17
B-2	30	B-22	17
B-3	30	B-23	17
B-4	30	B-24	17
B-5	30	B-25	17
B-6	30	B-26	17
B-7	30	B-27	17
B-8	30	B-28	17
B-9	30	B-29	17
B-10	17	B-30	17
B-11	17	B-31	17
B-12	17	B-32	17
B-13	17	B-33	17
B-14	17	B-34	17
B-15	17	B-35	17
B-16	17		
B-17	17		
B-18	17		
B-19	17		
B-20	17		

LEGEND:

 PROPOSED TEST BORING LOCATION




△	
△	
△	
△ 03/26/03	FOR LOUISVILLE DISTRICT CORP OF ENGINEERS APPROVAL
REVISION	DESCRIPTION

PROJECT:

Mason & Hanger Group
Aircraft Parking Apron and
Taxiway Replacement
Fort Dix, NJ

TITLE:

Geotechnical Investigation
Boring Location Plan



ENGINEERING TRANSPORTATION PHOTOGRAMMETRY SURVEYING
20 HANCOCK ROAD, NEWFORDLAND, NJ 07435
PHONE (973) 687-2122 FAX (973) 638-6432

DESIGNED: F&P	CHECKED: F&P
DRAWN: F&P	APPROVED: MRH
SCALE: 1"=150'	SHEET: NO. 1
DATE: 03/28/2003	PROJECT: GE-00002